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(54) **SIGNAL PROCESSING DEVICE FOR DISTRIBUTED ANTENNA SYSTEM**

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(63) Continuation of application No. 15/395,720, filed on Dec. 30, 2016, now Pat. No. 9,826,573, which is a continuation-in-part of application No. PCT/KR2015/005130, filed on May 22, 2015.

(51) **Int. Cl.**

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H04B 1/00	(2006.01)
H04B 1/40	(2015.01)
H04B 1/3888	(2015.01)

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CPC ***H04W 88/085*** (2013.01); ***H04B 1/00*** (2013.01); ***H04B 1/3888*** (2013.01); ***H04B 1/40*** (2013.01)

(58) **Field of Classification Search**

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(57) **ABSTRACT**

A signal processing device according to an exemplary embodiment of the inventive concept can integrate a power amplifier, a duplexer, and a linearizer as a module to improve the convenience of management and to improve flexibility and extensibility so as to be transformable corresponding to a change in system development concept.

7 Claims, 6 Drawing Sheets

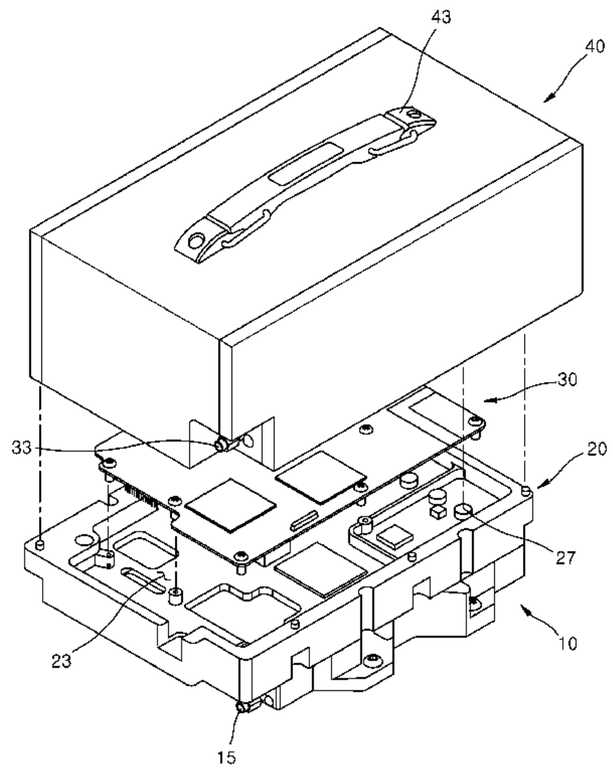

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FIG. 1

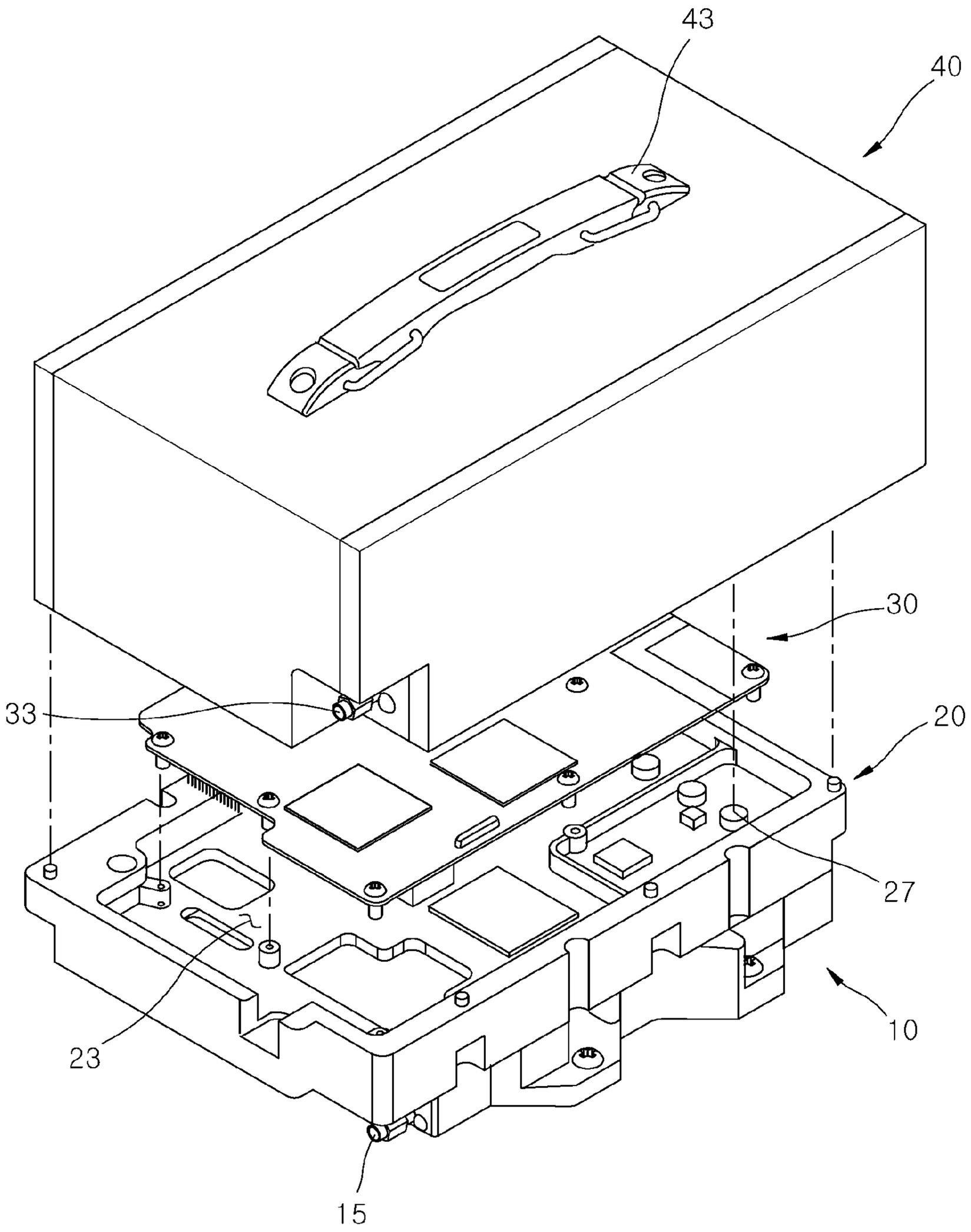


FIG. 2

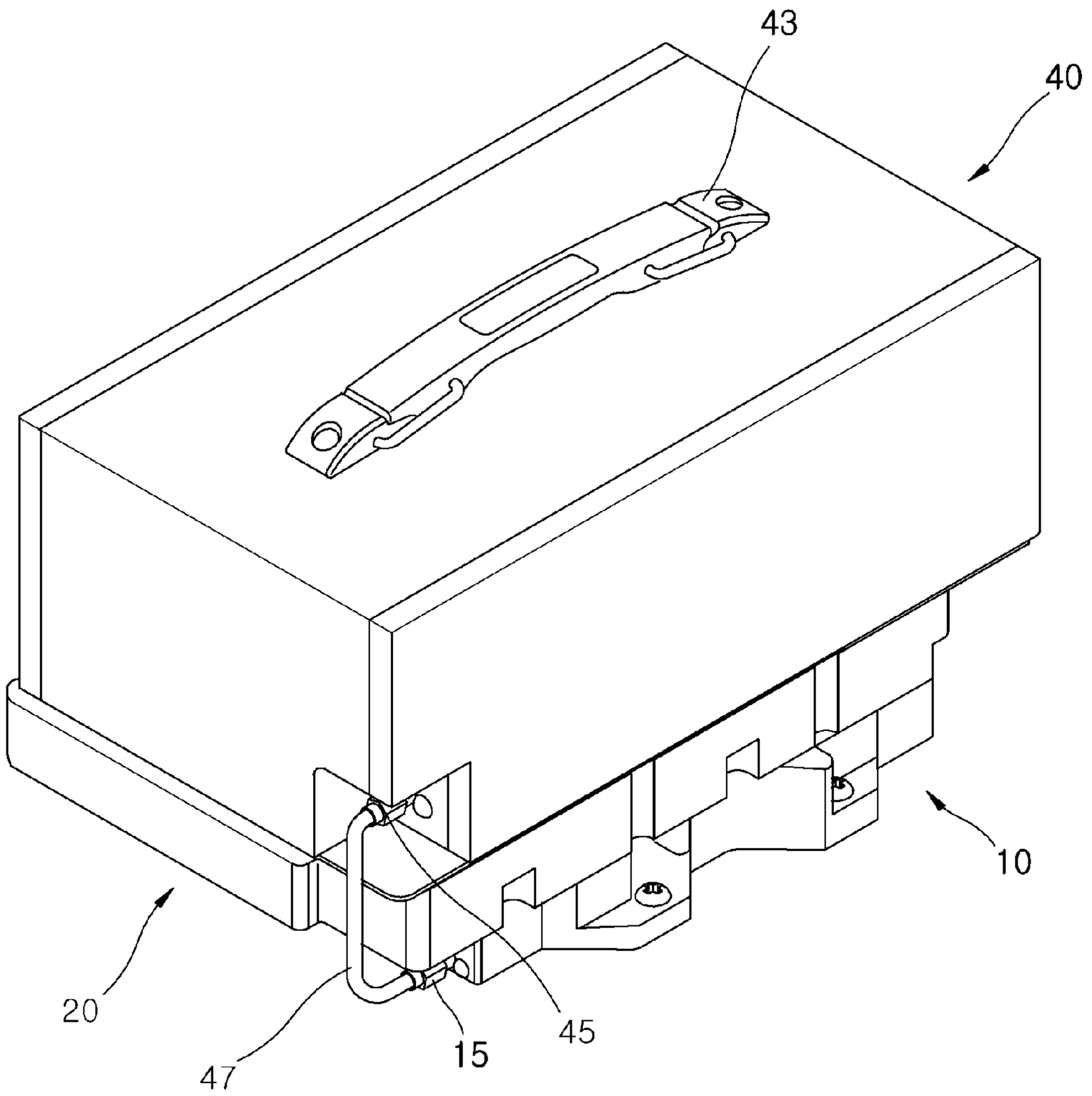


FIG. 3

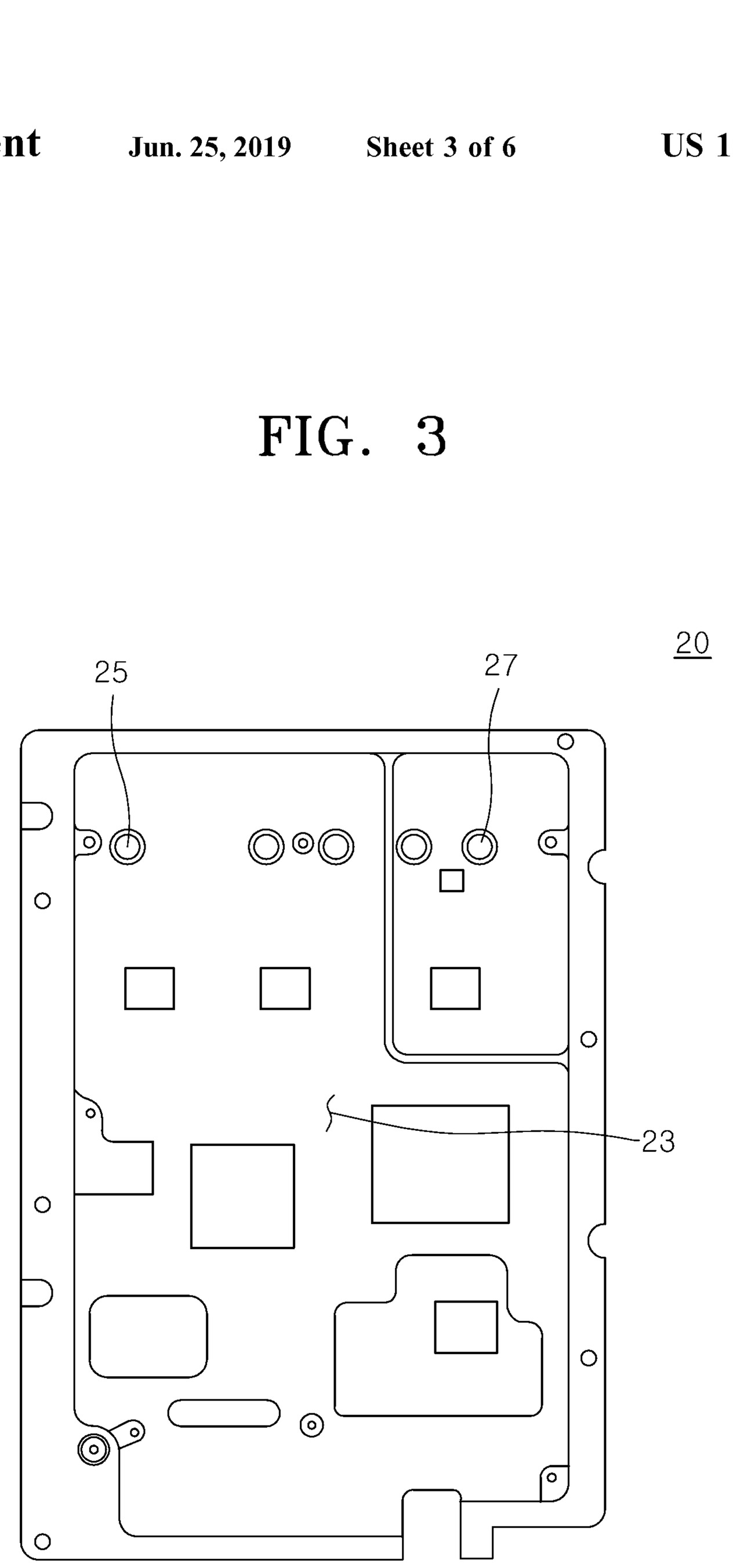


FIG. 4

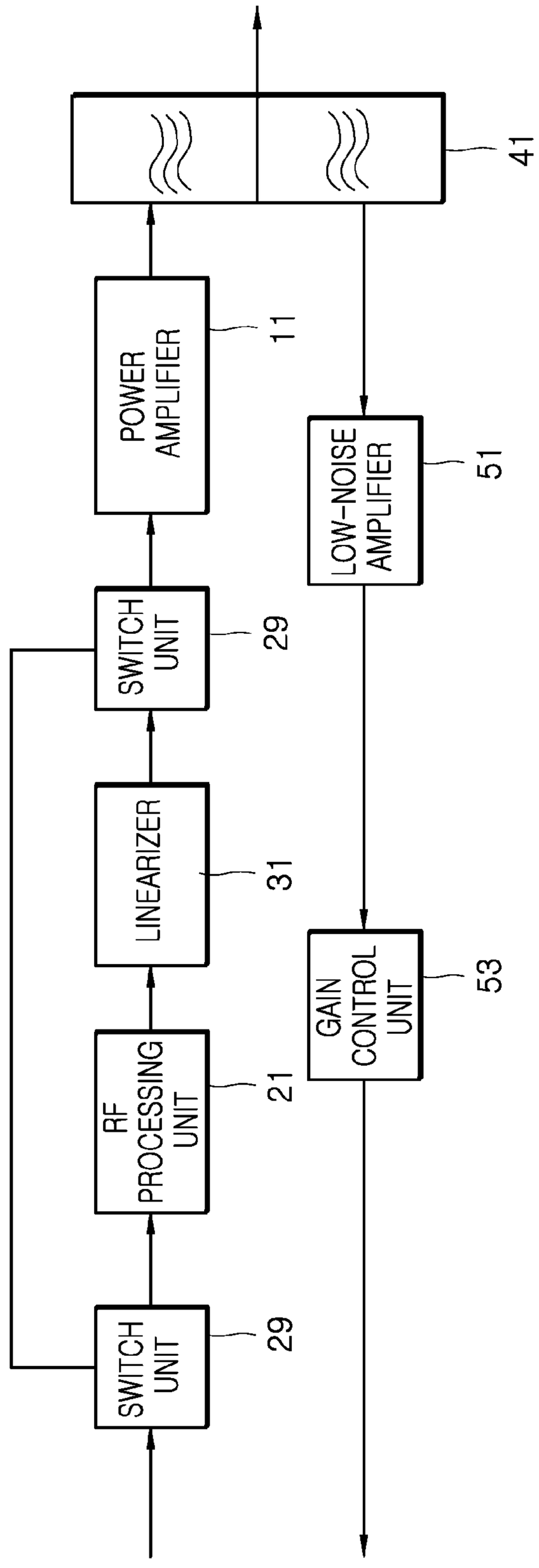

41
POWER AMPLIFIER
11
SWITCH UNIT
29
LINEARIZER
31
RF PROCESSING UNIT
21
LOW-NOISE AMPLIFIER
51
GAIN CONTROL UNIT
53
SWITCH UNIT
29

FIG. 5

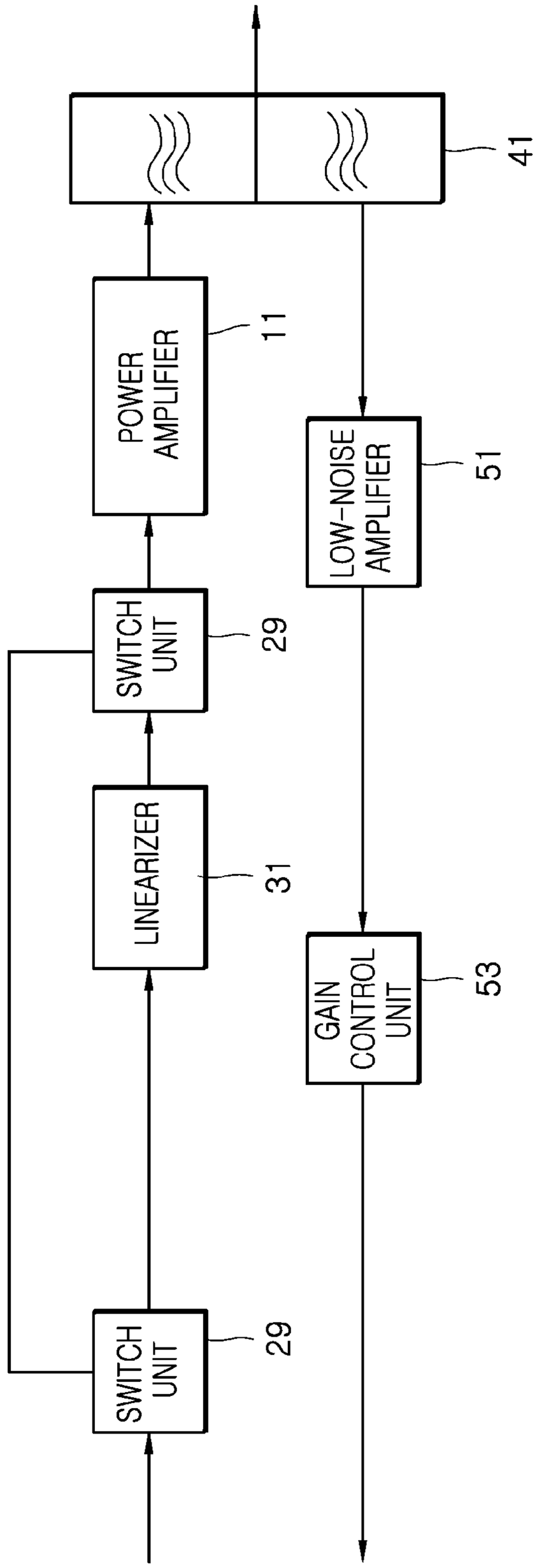
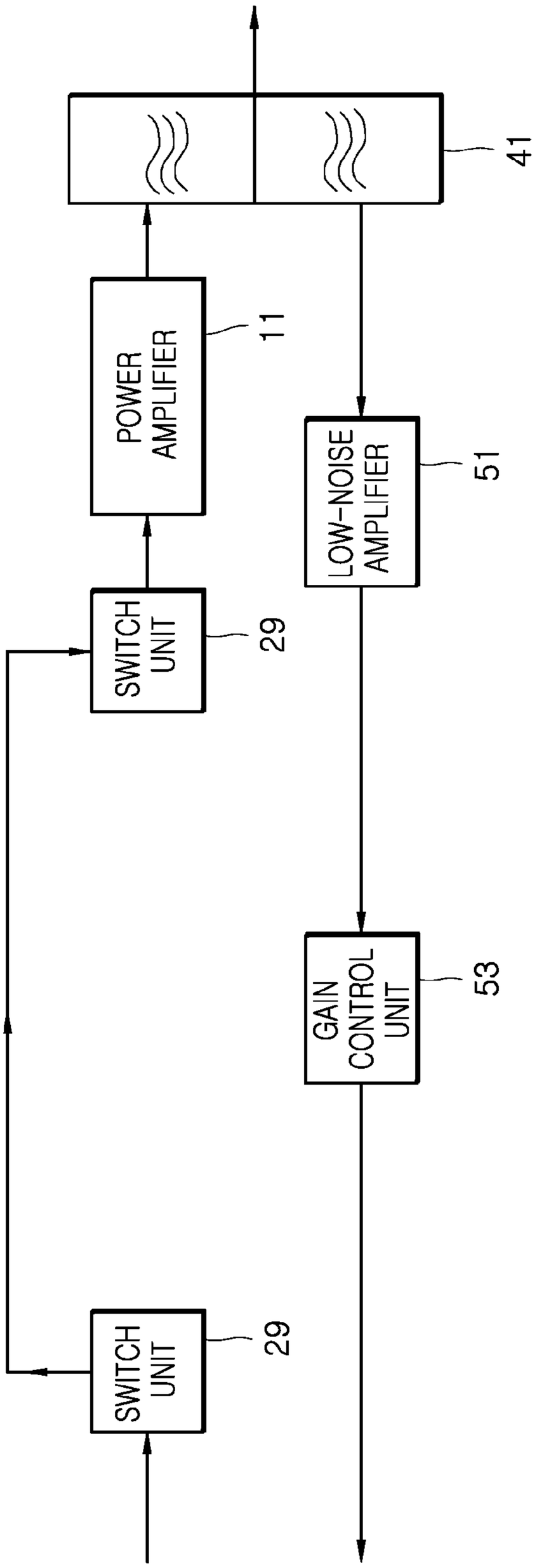

41
POWER AMPLIFIER
11
SWITCH UNIT
29
LINEARIZER
31
LOW-NOISE AMPLIFIER
51
GAIN CONTROL UNIT
53
SWITCH UNIT
29

FIG. 6


41
POWER AMPLIFIER
11
SWITCH UNIT
29
LOW-NOISE AMPLIFIER
51
GAIN CONTROL UNIT
53
SWITCH UNIT
29

SIGNAL PROCESSING DEVICE FOR DISTRIBUTED ANTENNA SYSTEM

CROSS REFERENCE TO RELATED APPLICATION

This is a Continuation of U.S. application Ser. No. 15/395,720, filed on Dec. 30, 2016, which is a Continuation-in-Part of International Application No. PCT/KR2015/005130, filed May 22, 2015, the contents of which are incorporated herein by reference in their entireties.

BACKGROUND

1. Field

The inventive concept relates to a signal processing device. More specifically, the inventive concept relates to a signal processing device that can improve the convenience of management by integrating a power amplifier, a duplexer, and a linearizer as a module and improve flexibility and extensibility so as to be transformable corresponding to a change in system development concept.

2. Description of Related Art

Mobile communication usage of users has been rapidly increased due to development of mobile communication and the users want to stably receive a communication service without the constraints of time and space. However, it is difficult for an operator to smoothly provide the communication service to the users while a shadow area is generated due to a limited output of a base station and a constraint such as the position or a peripheral geographical feature of the base station, and as a scheme for resolving such a problem, a distributed antenna system (DAS) is used.

The DAS is installed in an area in which a radio wave is not received or weakly received, such as the inside of a building, a basement of the building, a subway, a tunnel, an apartment complex of a residential area, a stadium, or the like, to provide the communication service up to the shadow area where a signal of the base station is difficult to reach and extend coverage of the base station, and consists of a headend apparatus that that is communicatively connected with the base station and a plurality of remote apparatus that is connected to the headend apparatus through a optical transport medium and is communicatively connected to a user terminal to process a signal.

In the plurality of remote apparatus of the DAS according to the related art, there are a lot of cases in which a deployment state of a power amplifier, a duplexer, and a linearizer or whether the power amplifier, the duplexer, and the linearizer are provided is decided according to a development concept of the system, and as a result, the system cannot be united and it is thus difficult to manage the plurality of remote apparatus and it is also difficult to efficiently cope with a change in operational environment of the system.

SUMMARY

The inventive concept relates a signal processing device that can improve the convenience of management by integrating a power amplifier, a duplexer, and a linearizer as a module and can also improve flexibility and extensibility so as to be transformable corresponding to a change in system development concept.

According to an exemplary embodiment of the inventive concept, there is provided a signal processing device including: a base module including a power amplifier; a first module coupled to the base module and selectively including an RF processing unit for processing an RF signal; a circuit substrate detachably coupled to the first module and including a linearizer correcting a distortion signal; and a second module covering the first module and including a duplexer separating a transmitted or received RF signal.

An accommodating groove accommodating the circuit substrate may be formed on one surface of the first module.

A first connector transferring a signal processed and introduced by the RF processing unit to the linearizer, and a second connector transferring the signal processed through the linearizer to the power amplifier may be provided on one surface of the first module.

The linearizer may include a pre-distortion device.

The signal processing device may further include a sensing unit provided in the first module to sense whether the circuit substrate is mounted or detached.

The signal processing device may further include a switch unit switching the signal processed by the RF processing unit to be processed by the linearizer and thereafter, transferred to the power amplifier at the time of mounting the circuit substrate according to a detection of whether the circuit substrate is mounted or detached by the sensing unit.

The switch unit may switch the signal introduced into the signal processing device to be bypassed to the power amplifier at the time of separating the circuit substrate according to a detection of whether the circuit substrate is mounted or detached by the sensing unit.

A signal processing device according to an exemplary embodiment of the inventive concept can improve the inconvenience of management by integrating a power amplifier, a duplexer, and a linearizer as a module and easily replacing or separating parts as necessary, and also can improve flexibility and extensibility so as to be transformable corresponding to a change in system development concept.

BRIEF DESCRIPTION OF FIGURES

The above and other aspects, features and advantages of certain exemplary embodiments of the inventive concept will be more apparent from the following description taken in conjunction with the accompanying drawings, in which:

FIG. **1** is an exploded perspective view of a signal processing device according to an exemplary embodiment of the inventive concept;

FIG. **2** is a perspective view of the signal processing device according to the exemplary embodiment of the inventive concept;

FIG. **3** is a diagram schematically illustrating a first module of the signal processing device according to the exemplary embodiment of the inventive concept; and

FIGS. **4** to **6** are usage state diagrams to which the signal processing device according to the exemplary embodiment of the inventive concept is applied.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

The inventive concept may have various modifications and various exemplary embodiments and specific exemplary embodiments will be illustrated in the drawings and described in detail through the detailed description. However, this is not intended to limit the inventive concept to the

specific exemplary embodiments, and it should be understood that the inventive concept covers all the modifications, equivalents and replacements included in the spirit and technical scope of the inventive concept.

In describing the inventive concept, when it is determined that the detailed description of the publicly known art related to the inventive concept may unnecessarily obscure the gist of the inventive concept, the detailed description thereof will be omitted. Further, numerical figures (for example, first, second, and the like) used during describing the specification are just identification symbols for differentiating one component from other components.

Further, in the specification, when it is mentioned that one element is "connected with" or "accesses" the other element, the one element may be directly connected with or directly accesses the other element, but if there is a not particularly contrary description, it should be appreciated that both elements may be connected with or accesses each other with another element intervening therebetween.

In addition, a term "~part (unit)", ~er", "~or", "~module", or the like, described in the specification means a unit of processing at least one function or operation and may be implemented by hardware or software or a combination of hardware and software.

In addition, it will be apparent that in the specification, components are just classified for each main function which each component takes charge of. That is, two or more components to be described below may be provided to be combined into one component or one component may be provided to be separated into two or more for each of more subdivided functions. In addition, each of the components to be described below may additionally perform some or all functions among functions which other components take charge of in addition to the main function which each component takes charge of, and some functions among the main functions which the respective components take charge of may be exclusively charged and performed by other components, of course.

A distributed antenna system means a coverage system for an in-building service that transfers voice communication and data communication with high quality for seamlessly accessing and means a system for servicing an analog and digital telephone system which is serviced in multiple bands through at least one antenna. Further, the distributed antenna system may enhance a poor radio wave environment in building and enhance a poor received signal strength indication (RSSI) and chip energy/others interference (Ec/Io) which is total receiving sensitivity of a mobile terminal.

Meanwhile, a distributed antenna system using a signal processing device according to an exemplary embodiment may support a mobile communication standard which is used worldwide. For example, the distributed antenna system may support frequencies such as a very high frequency (VHF), an ultra high frequency (UHF), 700 MHz, 800 MHz, 850 MHz, 900 MHz, 1900 MHz, 2100 MHz band, 2600 MHz band, and the like, and an FDD-scheme service and a TDD-scheme service. In addition, the distributed antenna system may support an advanced mobile phone service (AMPS) which is a representative of analog and multiple mobile communication standards such as Time-Division Multiplexing Access (TDMA), Code Division Multiple Access (CDMA), Wideband Code Division Multiple Access (WCDMA), High Speed Downlink Packet Access (HSDPA), Long Term Evolution (LTE), Long Term Evolution Advanced (LTE-A), and the like of digital.

Hereinafter, exemplary embodiments of the inventive concept will be described in detail with reference to the accompanying drawings.

FIG. **1** is an exploded perspective view of a signal processing device according to an exemplary embodiment of the inventive concept. FIG. **2** is a perspective view of the signal processing device according to the exemplary embodiment of the inventive concept. FIG. **3** is a diagram schematically illustrating a first module of the signal processing device according to the exemplary embodiment of the inventive concept. FIGS. **4** to **6** are usage state diagrams to which the signal processing device according to the exemplary embodiment of the inventive concept is applied.

In FIGS. **1** to **6**, a base module **10**, a power amplifier **11**, a first terminal **15**, a first module **20**, an RF processing unit **21**, a accommodating groove **23**, a first connector **25**, a second connector **27**, a switch unit **29**, a circuit substrate **30**, a linearizer **31**, a second module **40**, a duplexer **41**, a handle **43**, a second terminal **45**, a connection line **47**, a low-noise amplifier **51**, and a gain control unit **53** are illustrated.

Referring to FIG. **1**, the signal processing device according to the exemplary embodiment includes: a base module **10** including the power amplifier **11**; a first module **20** coupled to the base module **10** and selectively including the RF processing unit **21** for processing an RF signal; a circuit substrate **30** detachably coupled to the first module **20** and including the linearizer **31** compensating a distortion signal; and a second module **40** covering the first module **20** and including the duplexer **41** separating a transmitted or received RF signal to improve the convenience of management by integrating the power amplifier **11**, the duplexer **41**, and the linearizer **31** as a module and to improve flexibility and extensibility so as to be transformable corresponding to a change in system development concept.

A distributed antenna system (DAS) may include a headend apparatus (not illustrated), which is communicatively coupled to a base station and constitutes a headend node, and a hub apparatus serving as an extension node, and a plurality of remote apparatus respectively disposed at remote service location. The distributed antenna system (DAS) may be implemented as an analog distributed antenna system. However, the technical spirit of the inventive concept is not limited thereto. The distributed antenna system (DAS) may be implemented as a digital distributed antenna system and in some cases, implemented as a mixed type (for example, some nodes perform analog processing and residual nodes perform digital processing) thereof. The signal processing device according to an exemplary embodiment of the inventive concept may be mounted in at least one of the remote apparatus for processing a signal having a predetermined frequency band. According to one or more implementations, if the distributed antenna system (DAS) has employed a neutral host architecture to integrally support various services (e.g., multi-band services, multi-carrier services, etc.) or services of a plurality of providers, a plurality of the signal processing device may be mounted in the remote apparatus for a predetermined frequency band.

The signal processing device according to the exemplary embodiment may include a base module **10**, the first module **20**, the circuit substrate **30**, and the second module **40**.

The base module **10** may be coupled to the first module **20** to be described below and may include the power amplifier **11**. The power amplifier **11** may amplify a transmission signal to transmit the amplified transmission signal to the duplexer **41** to be described below.

The first module **20** may be coupled to the base module **10** and may selectively include the RF processing unit **21**.

The first module **20** may be coupled to the top of the base module **10** and may selectively include the RF processing unit **21** for processing a radio frequency (RF) signal. In the exemplary embodiment, it is described that the base module **10** and the first module **20** are configured as separate parts, respectively and the first module **20** is coupled to the top of the base module **10**, but the base module **10** and the first module **20** are formed as one component, and as a result, the power amplifier **11** and the RF processing unit **21** may be provided therein.

The RF processing unit **21** may be selectively provided in the first module **20**. That is, when it is determined that the RF processing unit **21** is required according to a system development concept, the RF processing unit **21** may be provided in the first module **20** and, when the RF processing unit **21** is not required or a separate RF processing unit **21** is provided outside the signal processing device, the RF processing unit **21** may not be provided in the first module **20**. The RF processing unit **21** which is used to process a transmitted RF signal may be an RF-IF conversion device that converts the RF signal into an intermediate frequency (IF) signal. In general, since the RF signal transmitted from the base station is a high-power signal, the RF signal is converted into a signal having appropriate power through the RF processing unit **21**. However, when the RF processing unit **21** is a component that may process the RF signal, the RF processing unit **21** may be configured in various schemes.

Meanwhile, the low-noise amplifier (LNA) **51** and the gain control unit (gain block) **53** used in a reverse-direction link may be provided in the first module **20**. Noise of a signal transferred through the duplexer **41** may be removed and power of the signal may be controlled while passing through the low-noise amplifier **51** and the gain control unit **53** to be output to the outside of the signal processing device (see FIGS. **4** to **6**).

The circuit substrate **30** may be detachably coupled to the first module **20** and may include the linearizer **31** that compensates a distortion signal. The circuit substrate **30** may be detachably coupled to the top of the first module **20** and mounted on the signal processing device as necessary. The linearizer **31** may be provided in the circuit substrate **30** to correct and linearize the distortion signal. The linearizer **31** may include a pre-distortion device. In this case, the pre-distortion device may be an analog pre-distortion (APD) device or a digital pre-distortion (DPD) device.

In detail, when the circuit substrate **30** is mounted on the signal processing device, the signal processed by the RF processing unit **21** is transmitted to the linearizer **31** of the circuit substrate **30** and the transmitted signal is compensated by the linearizer **31** and transmitted to the power amplifier **11**. On the contrary, when the linearizer **31** is not required and the circuit substrate **30** including the linearizer **31** is not mounted on the signal processing device according to the system concept, the signal introduced into the signal processing device is transmitted to the power amplifier **11**. Further, since an external input signal is an IF signal, when a separate RF-IF conversion device is not required in the signal processing device, the RF processing unit **21** may not be provided in the first module **20**. As such, in the signal processing device according to the exemplary embodiment, since the circuit substrate **30** including the linearizer **31** may be mounted/detached according to the system development concept, flexibility and extensibility may be improved as the signal processing device.

The second module **40** may cover the first module **20** and the second module **40** may include the duplexer **41** that separates the transmitted or received RF signal. The handle **43** is provided on the top of the second module **40** to facilitate transportation or installation of the integrated signal processing device. Meanwhile, a first terminal **15** may be formed at one side of the base module **10** and a second terminal **45** may be formed at one side of the second module **40**, and the first terminal **15** and the second terminal **45** may be connected by the connection line **47**.

As such, the power amplifier **11**, the duplexer **41**, the linearizer **31**, and the RF processing unit **21** may be integrated as the module, and parts may easily be replaced and detached as necessary to improve the convenience of management.

The accommodating groove **23** accommodating the circuit substrate **30** may be formed on one surface of the first module **20**. The accommodating groove **23** may be formed on the top of the first module **20** so as to correspond to the circuit substrate **30**, and the circuit substrate **30** may be inserted into the accommodating groove **23** to be provided in the signal processing device integrally with the first module **20**.

In this case, a first connector **25** and a second connector **27** may be formed on one surface of the first module **20**.

Referring to FIG. **3**, the first connector **25** is formed on one surface of the first module **20**, and as a result, the signal processed and introduced by the RF processing unit **21** is transferred to the linearizer **31**. The second connector **27** is formed on one surface of the first module **20** to be separated from the first connector **25** to transfer the signal processed through the linearizer **31** to the power amplifier **11**.

Meanwhile, the signal processing device according to the exemplary embodiment may further include a sensing unit provided in the first module **20** to sense whether the circuit substrate **30** is detachable. The sensing unit may determine whether the circuit substrate **30** is mounted or detached according to whether the circuit substrate **30** contacts the first module **20**. The sensing unit is provided in the first module **20** and actuates the switch unit **29** to be described below by detecting whether the circuit substrate **30** is mounted or detached to control the signal introduced into the first module **20**.

The switch unit **29** may switch the signal processed by the RF processing unit **21** to be processed by the linearizer **31** and thereafter, transferred to the power amplifier **11** at the time of mounting the circuit substrate **30** according to a detection of whether the circuit substrate **30** is mounted or detached. Further, the switch unit **29** may switch the signal introduced into the signal processing device to be bypassed to the power amplifier **11** at the time of separating the circuit substrate **30** according to a detection of whether the circuit substrate **30** is mounted or detached. In detail, when the circuit substrate **30** is mounted, the signal processed by the RF processing unit **21** is introduced into the linearizer **31** of the circuit substrate **30** through the first connector **25** and the signal processed by the linearizer **31** is transferred to the power amplifier **11** through the second connector **27**. Meanwhile, when the sensing unit senses that the circuit substrate **30** is detached from the first module **20**, the switch unit **29** operates to bypass the input signal introduced into the signal processing device and transfer the bypassed input signal to the power amplifier **11**.

FIGS. **4** to **6** are usage state diagrams to which the signal processing device according to the exemplary embodiment of the inventive concept is applied.

Referring to FIG. **4**, the exemplary embodiment shows a case in which the RF processing unit **21** and the linearizer **31** are required in the signal processing device according to the

system concept, the RF processing unit **21** is provided in the first module **20**, and the circuit substrate **30** including the linearizer **31** is mounted on the top of the first module **20**. The signal introduced into the RF processing unit **21** is subjected to signal processing such as frequency conversion by the RF processing unit **21** to be transferred to the linearizer **31**. The signal transferred to the linearizer **31** is compensated by the linearizer **31** and transferred to the power amplifier **11**. The signal transferred to the power amplifier **11** is amplified by the power amplifier **11** and thereafter, transferred to an antenna (not illustrated) through the duplexer **41**. In this case, the RF processing unit **21** may be an RF-IF conversion device for converting the RF signal into the IF signal and the linearizer **31** may be a linearizer including the pre-distortion device for correcting the converted IF signal.

Referring to FIG. **5**, the exemplary embodiment shows a case in which the linearizer **31** not including the pre-distortion device is required in the signal processing device according to the system concept, and the RF processing unit **21** is not provided in the first module **20** and the circuit substrate **30** including the linearizer **31** is mounted on the top of the first module **20**. The input signal is transferred to the linearizer **31** and the signal transferred to the linearizer **31** is corrected and transferred to the power amplifier **11**. The signal transferred to the power amplifier **11** is amplified by the power amplifier **11** and thereafter, transferred to an antenna (not illustrated) through the duplexer **41**.

Referring to FIG. **6**, an exemplary embodiment shows a case in which the linearizer **31** is not required in the signal processing device according to the system concept and the RF processing unit **21** is not provided in the first module **20** and the linearizer **31** is not also provided. The sensing unit determines whether the circuit substrate **30** is separated from the first module **20** according to whether the circuit substrate **30** contacts the first module **20** and the switch unit **29** switches the signal to bypass the input signal introduced into the signal processing device to the power amplifier **11**.

As described above, the signal processing device according to the exemplary embodiment may integrate the power amplifier **11**, the duplexer **41**, and the linearizer **31** as the module to improve the convenience of the management and improve the flexibility and extensibility so as to be transformable corresponding to the change in system development concept.

Hereinabove, the inventive concept has been described in detail with reference to the preferred embodiment, but the inventive concept is not limited to the embodiment and various modifications and changes may be made by those skilled in the art within the technical spirit and scope of the inventive concept.

What is claimed is:

1. A signal processing apparatus comprising:

a base module including a power amplifier;

a first module coupled to the base module and selectively including an RF processing unit for processing an RF signal;

a circuit substrate detachably coupled to the first module; and

a second module covering the first module and including a duplexer separating a transmitted or received RF signal.

2. The signal processing apparatus of claim **1**, wherein the circuit substrate includes a linearizer.

3. The signal processing apparatus of claim **2**, wherein the linearizer is a pre-distorter.

4. The signal processing apparatus of claim **2**, wherein a first connector transferring a signal processed and inputted by the RF processing unit to the linearizer, and a second connector transferring the signal processed through the linearizer to the power amplifier are provided on one surface of the first module.

5. The signal processing apparatus of claim **2**, further comprising:

a sensing unit provided in the first module to sense whether the circuit substrate is mounted or detached.

6. The signal processing apparatus of claim **5**, further comprising:

a switch unit switching the signal processed by the RF processing unit to be processed by the linearizer and thereafter, transferred to the power amplifier at the time of mounting the circuit substrate according to a detection of whether the circuit substrate is mounted or detached by the sensing unit.

7. The signal processing apparatus of claim **6**, wherein the switch unit switches the signal inputted into the signal processing apparatus so as to be bypassed to the power amplifier at the time of detaching the circuit substrate according to a detection of whether the circuit substrate is mounted or detached by the sensing unit.

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